

**REMARKS**

In response to the rejection of claims 10 and 20 under 37 C.F.R. 1.75(c), applicants have amended claims 10 and 20 to be independent to overcome the rejection. Claims 11 and 21 have been amended to correct the phrase "group (iv)" to "group (iii)" as noted by the Examiner. As also noted by the Examiner, claims 22, 24 and 26 have been amended by deleting the second listing of the ion A<sup>3+</sup>

To overcome the rejection of claims 22, 24 and 26 under 35 U.S.C. 112, applicants have amended these claims by deleting all the elements containing the charge of "n+".

The rejection of claims 1-3, 5, 22 and 23 under 35 U.S.C. 102(b) as anticipated by Dalton, Jr. et al; the rejection of claims 12, 24 and 25 under 35 U.S.C 102(b) as anticipated by Dalton, Jr. et al; rejection of claims 13,14, 26 and 27 under 35 U.S.C. 102(b) as anticipated by Dalton, Jr. et al; rejection of claim 4 under 35 U.S.C. 103(a) as being unpatentable over Dalton, Jr. et al in view of Roman; the rejection of claim 6 under 35 U.S.C. 103(a) as being unpatentable over Dalton Jr. et al as applied to claim 5, and further in view of Norman et al and Roman; the rejection of claim 7 under 35 U.S.C. 103 (a) as being unaptentable over Dalton, Jr. et al as applied to claim 5, and further in view of Norman et al and Roman; the rejection of claim 9 under 35 U.S.C. 103(a) as being unpatentable over Dalton, Jr. et al as applied to claim 1 and further in view of Roman; the rejection of claim 15 under 35 U.S.C. 103(a) as being unpatentable over Dalton, Jr. et al as applied to claim 13 and further in view of Norman et al and Roman; the rejection of claim 17 under 35 U.S.C. 103(a) as being unpatentable over Dalton J. et al as applied to claim 13 and further in view of Roman; and rejection of claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dalton, Jr. et al as applied to claim 1 and further in view of Norman et al and Roman are noted.

It is noted that claims 8, 16, 18, 19 and 10, 11 20 and 21 would be allowable subjected to formal revisions.

Primary novel features of the subject invention are to organize oxygen carrier molecules in a solid phase by intermolecular interaction so that the

intermolecular interactions create cavities around active metal centers for interaction with oxygen molecules, and the intermolecular interactions create passages that interconnect the cavities so that oxygen molecules can quickly access all active metal sites.

The primary objection by the Examiner is the Dalton, Jr. et al reference. Dalton, Jr. et al discloses use of secondary metals (aluminum) in oxygen adsorbents, specifically the lines (column 5, lines 21-33) cited in the U.S. Patent No. 4,421,531 are:

"In order to insure sufficient heat capacity in the beds of dioxygen adsorbents, it is possible to add an inert material to locally dissipate heat from the chelate and store the exothermic heat of reaction generated during adsorptions. Beneficial inert materials have a high heat capacity, such as copper fillings and particulate aluminum oxide (Al<sub>2</sub>O<sub>3</sub>). The inert high heat capacity material may be mixed with the dioxygen complex in a predetermined proportion so as to limit the temperature rise of the dioxygen complex during an adsorption cycle. The dioxygen complex can be physically supported on the inert high heat capacity material."  
(Underscore added.)

Certain elements of the subject invention are present in Dalton, namely G to G<sub>4</sub>, M, and D to D<sub>4</sub>. These define a general class of molecules referred to as Transition Element Complexes. The primary difference with regard to Dalton is the intermolecular connecting groups with secondary metal ions that coordinate with secondary donors that are connected to one or more G to G<sub>4</sub> groups on the respective TECs. Therefore, the arguments presented herein refer only to the intermolecular connecting groups.

Applicants respectfully disagree with the Examiner's interpretation of Dalton. Column 3 lines 1-48 do indeed disclose transition metals complexes but do not disclose that the materials are porous. Column 4 line 62 to Column 5 line 3 describes a subset of compositions that also have a group that could serve as a potential secondary donor for intermolecular interaction, namely x, x<sup>1</sup> = CH<sub>3</sub>CH<sub>2</sub>O or CH<sub>3</sub>O (Column 5 line 3). Similarly, the material represented in Column 4 lines 32-51 has SO<sub>3</sub> groups that could serve a similar function. However, Dalton does not disclose the secondary metal ions coordinated with secondary donors (O). The Examiner refers to Column 5 lines 22-23 to make

the case that the secondary metal ion aluminum. However, Dalton refers to the use of “copper fillings or particulate aluminum oxide” as an *inert component* to provide additional heat capacity (Column 5 lines 27-33). Applicants do not regard the secondary metal ions as inert – they are a feature of the subject invention. More significantly, Dalton alludes to copper *fillings* or *particulate* aluminum oxide, which represent extended array of atoms. This is further emphasized by Dalton’s use of the term “physically supported” (Column 5 line 32). The secondary metal ions according to the subject invention are an intimate component of the porous solid on a molecular level. Also, in contrast to Dalton, the secondary metal ions according to the subject invention are associated with each primary metal ion. In contrast, Dalton describes use of aluminum oxide to create a physical mixture with the dioxygen complex based on macroscopic particles.

Based on applicants’ arguments that Dalton does not disclose intermolecular connecting groups due to lack of a secondary metal ion, the comments relating to Claim 2, 3, 5, 22, and 23 are no longer relevant (Examiner point 11). Similarly, the objections to Claims 12, 24, and 25 are no longer relevant (Examiner point 12). Similarly, the objections to Claims 13, 14, 26, and 27 are no longer relevant (Examiner point 13).

A key aspect of the subject invention is embodied in Claim 1 (e), which uses intermolecular connecting groups to organize molecules in solids. Most oxygen carriers that function in solution do not adsorb oxygen in the solid state. Oxygen carrier molecules in solution are mobile and separated by solvent molecules. As a result, the oxygen carrier molecules in solution are accessible to oxygen molecules. In contrast, molecules in solids tend to pack efficiently and block the access to the oxygen-binding sites. To overcome this problem, the present invention uses intermolecular connecting groups (R) to organize molecules and create pores in the solid phase so that gaseous dioxygen can readily access the oxygen binding sites. None of the cited reference discloses or suggests use of intermolecular connecting groups.

Dalton, Jr. et al discloses an adiabatic pressure swing adsorption process for removal of oxygen. The prior art also discloses Co(salen) derivatives such as Fluoramine. None of those oxygen carriers contains an intermolecular connecting group, which is disclosed in Claim 1 (e) in the subject invention.

Norman et al discloses oxygen carrier molecules used in solution or in membranes while solid materials are disclosed in the current invention. In addition, none of oxygen carriers contain an intermolecular connecting group.

Roman discloses a process of separation and purification of oxygen and nitrogen using solution of oxygen carriers whereas the subject invention discloses solid oxygen adsorbents. Furthermore, none of the oxygen carriers contain an intermolecular connecting group.

The novelty of the present invention is the methods to organize oxygen carriers in the solid phase so that the active site on the oxygen carrier molecules can be readily accessible to oxygen molecules. Similar oxygen carrier molecules are disclosed in prior art. However, the subject invention teaches that to organize those molecules in the solid state is novel.

In the subject invention, the secondary metal ions are used to intermolecularly connect each individual oxygen carrier species in the homogeneous adsorbent phase. The role of the secondary metal ions is to organize the oxygen carrier species in three dimensions so that channels and pores are created throughout the metal.

Dalton, Jr. et al do not use aluminum in  $\text{Al}_2\text{O}_3$  as a secondary metal ion in the same fashion as the present invention. In the prior art the inventors employ particulate aluminum oxide as an inert material to dissipate adsorption heat so that fluctuation of the temperature in the adsorbent bed caused by sorption and desorption heat is minimized. The oxygen carriers and the inert material are in two distinct phases. The inert material is added by two different methods:

- a) In the first method, the inert material ( $\text{Al}_2\text{O}_3$ ) is mixed with dioxygen complex. This means that aluminum oxide particles and dioxygen complex particles are physically mixed. These two materials are in two distinct phases and there are not chemical bonds between atoms in the inert material (aluminum ion) and those in the dioxygen complex phase. Copper fillings or aluminum oxide exist as pure phases in the mixture. The statement in the patent does not imply that the aluminum oxide and oxygen carrier molecules are mixed to form a homogeneous phase because aluminum oxide is insoluble in any solvent without changing the chemical composition and does not melt at a temperature that does not decompose the oxygen carrier molecule. In

the prior art, the appropriate proportion of the inert material is used for limiting the temperature rise of the dioxygen complex during and adsorption cycle, not for changing the chemical composition. In contrast, the subject invention uses secondary metal ions to bind oxygen carrier species to form a homogenous phase in molecular level.

b) In the second method, an oxygen carrier was physically supported in an inert material. This usually is achieved by depositing oxygen carrier microcrystals on the support particles. The oxygen carrier and the support material are two distinct phases and any interaction between molecules from two materials only occurs on the interface between the particles. This is different from the subject invention that discloses the use of secondary metal ions to organize molecular structure substantially throughout the materials, not just on the surface of particles.

Applicants respectfully disagree that it would have been obvious to one of ordinary skill in the art to combine Dalton and Roman to achieve the subject invention. Indeed, neither one of these patents teaches intermolecular connecting groups which is a key feature of this invention. Indeed, it was not recognized prior to this invention that the intermolecular connecting groups could be used to produce a porous structure. Dalton describes systems that contain  $\text{CH}_3\text{O}$  or  $\text{NO}_2$  groups. As disclosed by Dalton, these groups represent neutral entities and the entire transition metal complex is neutral. Although  $\text{CH}_3\text{O}$  can be formally regarded as an alkoxy group, in reality, it is combined with a hypothetical cationic aromatic entity to create a neutral fragment. Although some of the peripheral groups may be suitable for such an interaction, applicants are not aware of any prior art that would suggest that it is desirable or achievable. Without the subject invention, there would be no incentive to combine them (Examiner point 15).

The claim 6 rejection of Dalton and in view of Norman and Roman is without merit. Although Roman discloses 4-methoxypyridine, it is a neutral entity and therefore does not require the charge-balancing cation. The Examiner's representation of 4-methoxypyridine as 4-Py-O does not represent the chemistry involved and would imply a charge balancing  $\text{CH}_3^+$ . In contrast, the subject invention discloses the use of the lithium salt of 4-hydroxypyridine which is ionic and does involve a cation to serve as a secondary metal ion. Since Roman does

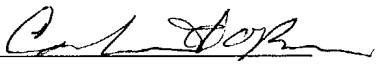
not teach the appropriate charge pyridine group, the intermolecular assembly is not obvious (Examiner point 16).

The arguments above also apply to rejection of claim 9 (Examiner point 17) in that Roman teaches 4-methoxypridine but that this is neutral and is not accurately represented as 4-Py-O. This also extends to Claim 15 (Examiner point 19), Claim 17 (Examiner point 20), and Claim 28 (Examiner point 21).

It is respectfully requested that this amendment be entered by the Examiner. No new matter has been introduced and the rejections are requested to be withdrawn. Formal drawings are attached along with a paper requesting approval of the drawings.

In light of the above amendments and remarks, reconsideration of the pending application is requested.

Respectfully submitted,

  
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